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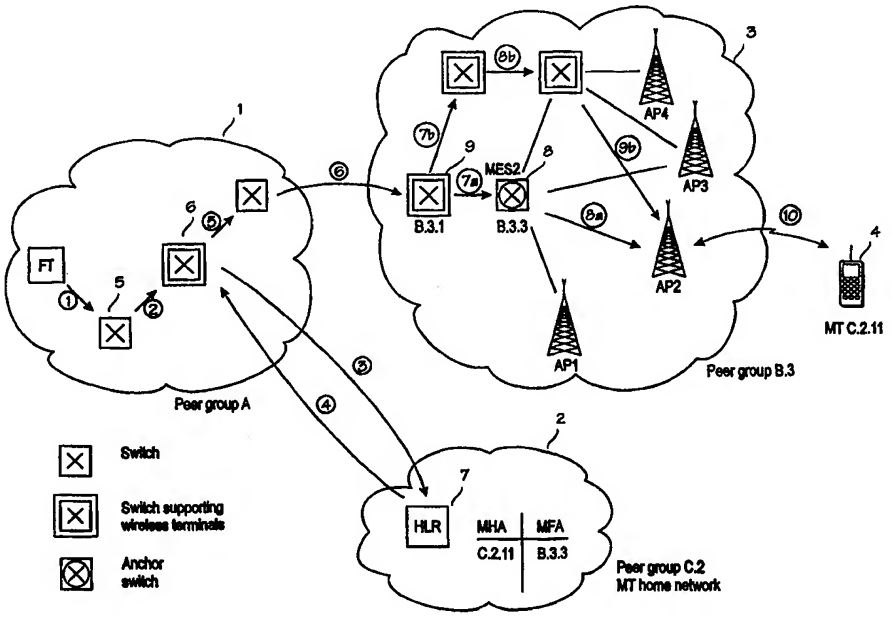

(57) Abstract

The invention relates to a connection–oriented packet network comprising hierarchically arranged peer groups (1, 2, 3) and at least one home data base, a temporary location information in the home data base comprising an address of a peer group in which a mobile terminal or mobile subscriber is last registered. A set–up message is routed to a destination peer group according to the temporary location information. Each member in a peer group has information for routing the set–up message forward to a mobile terminal within the peer group.

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LOCATION MANAGEMENT IN A CONNECTION-ORIENTED PACKET NETWORK

FIELD OF THE INVENTION

The invention relates to telecommunication systems and particularly to a connection-oriented packet network comprising hierarchically arranged peer groups.

BACKGROUND OF THE INVENTION

The tendency in telecommunication industry is towards new high-quality services the implementation of which requires high bit rates. As network systems advance and grow larger, optimal management of data transmission between networks becomes increasingly important.

Among solutions attracting interest are broadband networks, the bit rates of which typically exceed 2Mbit/s. The transfer technique selected for such B-ISDN networks (Broadband Integrated Services Digital Network) is ATM (Asynchronous Transfer Mode). ATM transmission technique is a switching and multiplexing solution, particularly associated with a data link layer (OSI Layer 2), that allows a connection-oriented network to be implemented in B-ISDN networks.

The present invention can be applied in connection with various connection-oriented packet networks to which routers (such as a TCP/IP protocol) supporting wireless terminals can be added. The invention will be illustrated using elements and terms of ATM transfer technique, without the invention being, however, restricted to them.

In ATM, an end user's data traffic is conveyed from a source to a destination through virtual connections. The data is transferred in the network through switches in fixed-length packets of 53 octets called ATM cells. Figure 1 illustrates the structure of ATM cells. A cell comprises a header of five octets and an information field of 48 octets, which comprises the actual payload. The physical layer can comprise a plural number of virtual paths multiplexed in an ATM layer. The paths are identified by means of a Virtual Path Identifier VPI. At a User-to-Network Interface UNI the VPI is 8 bits long and at a Network-Node-Interface NNI it is 12 bits. Each virtual path can comprise a plural number of virtual channels identified by a Virtual Channel Identifier VCI of 16 bits.

The main function of the header is to identify an interface number for a cell sequence that is transferred through a virtual channel associated with

the connection. In addition to the above, the header also comprises other fields such as a Header Error Control HEC, a Generic Flow Control GFC, a Cell Loss Priority CLP and a Payload Type PT. An ATM cell indirectly comprises information about the address of the receiver, so each cell is an independent information transport unit. The number of cells transferred in a time unit is proportional to the user's bandwidth requirements.

ATM is a connection-oriented communication technique, but because a connection does not exist before it is set up, a connection set-up request must be routed from a source through the ATM network to a destination in just about the same way as packets are routed in packet-switched networks. After connection set-up, the packets travel on one and the same virtual channel during the connection. ATM Forum proposes routing to be implemented by a PNNI (Private NNI) protocol, the characteristics of which are described in greater detail for instance in *PNNI Specification, version 1.0, ATM Forum document af-PNNI-0055.000, ATM Forum, 1996.*

The PNNI protocol functions between ATM switching systems, such as individual switches or entire networks, connected by PNNI links. A PNNI link can be a physical link or a virtual link. A PNNI link can for instance be a virtual path combining two nodes. As regards the PNNI protocol, the nodes are logically parallel.

The PNNI comprises in principal two components: a PNNI signalling protocol and a virtual circuit routing protocol. The PNNI signalling protocol is used for transmitting ATM connection set-up messages in the network between the user-to-network interface of the source and the destination. UNI signalling is converted to NNI signalling in the destination switch. The virtual circuit routing protocol is used for routing the signalling request through the ATM network. This idea is illustrated in Figure 2, which shows signalling used for setting up a connection between two fixed terminals FT1 and FT2.

The development of the PNNI protocol aims at two primary goals: flexible extendibility and routing based on Quality of Service. The PNNI protocol routes a connection primarily on the basis of a requested Quality of Service QoS, traffic parameters and the resources available to the network. In connection with the connection set-up request, the desired quality of service is defined and then maintained during the entire connection. This is based on the Connection Admission Control CAC performed by the ATM switches, the function of which, simply put, is to ensure that as the switch receives a

connection set-up request, it checks whether it can set up the connection without causing interference to existing connections. The switch approves the connection only if no interference is to be expected, otherwise the connection is routed through another switch.

In the PNNI protocol flexible extendibility is implemented by a hierarchical network organization, which involves an exchange of combined availability information between different levels of the hierarchy. Figure 3 illustrates the PNNI hierarchy. Each PNNI hierarchy level follows the same recursive network model so that in principle the same mechanisms are used at each hierarchy level. Each hierarchy level comprises groups called peer groups. A peer group is substantially a plural number of groups which all have access to an identical topological database and which exchange with each other link status data. For a peer group at a higher hierarchical level, each lower level peer group appears as a logical group node exchanging, similarly as a normal node, parameters concerning the status of links and nodes with other nodes at the same level. Each peer group has a node that functions as a Peer Group Leader PGL, performing the functions of a logical group node. The status data of higher level peer groups is aggregated between the hierarchy levels, so the members of one and the same peer group know the status data of their own group in detail and the data concerning the higher levels with less accuracy, depending on how the distance between the hierarchy levels of the groups concerned.

The status data of network elements in the PNNI protocol has been proposed to be transferred by Topology State Packets PTSP. The packets comprise a large amount of status parameters of links and nodes, denoting the communication circumstances within the network. Transfer of status data can be activated on the basis of specific events and status data in the PNNI protocol has also been planned to be flooded at a desired accuracy at regular intervals within the entire network. Flooding makes updated status data available at a selected level in the entire network and members of one and the same peer group in particular will know the data concerning their peer group in detail.

Members of one and the same peer group are interconnected by horizontal links. Border nodes are peer group nodes having a link to other peer groups, also to external networks, that do not apply the PNNI protocol. Border nodes in different peer groups at one and the same hierarchy level determine

each other as an uplink to a corresponding peer group and they also broadcast link availability data within the peer group.

An interesting recent development trend is the introduction of wireless data transmission and mobility to connection-oriented data transmission networks. This means that a network is extended over an air interface to wireless terminals. Current standards as such do not support the additional characteristics required by wireless data transmission, but various solutions for implementing mobility management for instance in connection with ATM have already been put forward. The aim is to add wireless data transmission and mobility to the ATM network without significant changes to existing ATM networks and standards.

The publication *[AF96-1699] 'Tunnelled Signalling for the Support of the Mobile ATM', ATM Forum Contribution 96-1699, by Potter, Gilmurray (ORL), 1996,* provides a description of an excellent method supporting the PNNI protocol for routing connections in a wireless ATM network. Mobility of ATM equipment is proposed to be implemented by means of tunnelled signalling supported by an updating service. In the prior art approach a mobile terminal is given a Home Address MHA to be stored in the permanent memory and used in the SETUP message of the connection set-up request. It proposes an allocation of MHA addresses whereby it would be possible to conclude directly on the basis of the address whether the address is associated with a mobile terminal or not. As a mobile terminal registers in a visitor network, it is given a Mobile Foreign Address MFA. The home network of the mobile terminal maintains the data of its home address and its mobile foreign address at a given time. Whenever a mobile terminal registers in a new switch, information about a new mobile foreign address MFA is updated in the home network of the mobile terminal. As a connection set-up message arrives at the switch and the switch detects that the destination address of the message is associated with a mobile terminal, the original destination address of the message is encapsuled in the message and a mobile foreign address MFA received from the home network is used as the routing address. As the message arrives at the switch indicated by the foreign mobile address, the encapsulation is released and the message is routed to the mobile terminal.

Encapsulation allows a connection set-up message to be transparently routed to a mobile terminal through the network, using a PNNI protocol. In the prior art approach, as in other methods that have been

presented, the encapsuled message is typically routed to an anchor switch that is connected to a base station in which the mobile terminal is registered. As regards mobility management, location monitoring arranged at the accuracy of switches is not, however, the most advantageous alternative. When the routing of a wireless terminal is determined so as to traverse particular switches, an advantage that a hierarchical network structure offers remains unused, i.e. the possibility to guide routing on the basis of traffic-related parameters selected for the terminal, for instance along the shortest route available or avoiding congested links. Traffic forced to particular switches makes the routing ineffective and thus reduces the quality of service, shown for instance by a longer delay or an increased number of lost cells. In addition, connections may become congested at an anchor switch, whereby the capacity of switch buffers and the available bandwidth soon run out.

A subscriber moving from one anchor switch service area to another always activates a new registration and a related location updating to the subscriber's home network. If the service are of the switch is small and subscribers move frequently, the network, and the switch used as the destination address for the encapsulation in particular, become loaded by the extra signalling required by the mobility management. If a subscriber visits a network that is far away from the home network, location updating messages have to be conveyed a long distance, and therefore it would be desirable to minimize the amount of signalling. If the anchor switch service area is enlarged, there is, correspondingly, a risk that the switch becomes congested.

BRIEF SUMMARY OF THE INVENTION

An object of the invention is to provide a solution that will enable a connection set-up message and subsequent communication packets associated with the connection be routed through the network in such a way that the above mentioned problems can be solved without causing significant changes to existing networks.

The object of the invention is achieved with a connection-oriented packet network according to claim 1. Said network is characterized by the temporary location information in the home data base comprising an address of a peer group in which the mobile terminal or mobile subscriber is last registered and that said parameters significant for routing comprise information for an internal routing within a peer group.

The invention also relates to a mobile terminal according to claim 9 for a connection-oriented packet network said network comprising hierarchically arranged peer groups in which the members of a peer group are arranged to know traffic parameters significant for routing to other members in the respective peer group, said network comprising at least one home data base for storing location information of mobile terminals or subscribers in the form of temporary addresses. The mobile terminal is characterized by said temporary address comprising the address of a peer group in which the mobile terminal or subscriber is last registered, and the mobile terminal being arranged to update the location information in the home data base as it moves from one peer group to another.

The invention further relates to a method according to claim 10 for routing a message in a connection-oriented packet network comprising hierarchically arranged peer groups, in which the members of each peer group know the traffic parameters significant for routing to other members in the same peer group, said method comprising the steps of

receiving at a first network node, which supports the management of mobile terminals, a connection set-up message comprising a permanent address of a called mobile terminal or mobile subscriber;

sending from the first network node a routing information inquiry to a home data base of the called mobile terminal or mobile subscriber, the location information of mobile terminals or subscribers being stored in the data base in the form of temporary addresses;

providing to the first network node, as a response, the address of the called mobile terminal or subscriber;

routing the connection set-up from the first network node, from the switch onward, by using said temporary address as a destination address of the connection. The method is characterized by

storing, in said home register, the address of a peer group in which the mobile terminal or subscriber is last registered as the temporary address;

routing the connection set-up on the basis of said peer group address to the peer group concerned;

routing the connection set-up arrived at the peer group forward within the peer group using the traffic parameters significant for routing.

The dependent claims relate to the preferred embodiments of the invention.

The invention is based on monitoring the location of a mobile terminal/subscriber so that the location data in the home data base indicates the location, instead of an individual network node or switch, at the accuracy of a peer group. The subscriber's location is known at the accuracy of a node at least within the peer group (i.e. the serving node is known). Location update to the home network is performed primarily when the mobile terminal/subscriber moves from one peer group to another. The switch routing the connection set-up message and performing location inquiry to the data base comprising the location information routes the set-up message to a temporary address received, i.e. to an address of a peer group. The set-up message travels according to the protocol towards said peer group. When the message arrives at a border node of the peer group, the border node detects the set-up message is addressed to a mobile terminal or mobile subscriber and either routes the message to the mobile terminal or, if the border node does not comprise sufficient functionality for performing routing, it sends the set-up message to another peer group node that can route the message to the terminal. Within a peer group, routing is performed using internal data management of the peer group, which provides every member of the group with information about traffic parameters significant for routing to other members in the same peer group. According to the invention, the information comprises an identity or an address of a base station serving a wireless terminal. This information can be broadcast within the peer group by using a PNNI flooding known per se. Thus the border node already has the information for routing the set-up message within the peer group.

The present invention enables a more efficient routing by making use of the advantages offered by a hierarchical network structure and network protocol in the implementation of wireless connections, avoiding at the same time above described problems. Due to the invention, location update signalling has no impact on the size of the anchor switch service area, because the location information at the home data base only needs to be updated when the mobile terminal or mobile subscriber changes peer group. The method is easy to implement and does not cause significant changes to existing networks or protocols. As signalling related to mobility management is reduced, also distributed data base operations become easier to implement.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail in connection with preferred embodiments, with reference to the attached drawings, in which

Figure 1 illustrates a structure of ATM cells;

Figure 2 illustrates nodes in a PNNI protocol;

Figure 3 illustrates a hierarchical structure of a PNNI protocol and a concept of a peer group;

Figure 4 is a block and signalling diagram illustrating prior art routing of a connection set-up message using tunnelling;

Figure 5 is a block and signalling diagram illustrating an advantage gained by means of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 4 is a block and signalling diagram illustrating prior art routing of a connection set-up message using tunnelling. The example shows three peer groups A, B and C. A fixed terminal FT at an address A. 10. in peer group A sends a connection set-up request to a mobile terminal MT 4 at a home address MHA C.2.11 in peer group C.2. Switches 5, which do not support the management of mobile terminals, route the connection set-up message as usually towards peer group C.2 (steps 1 and 2). When the set-up message arrives at a switch MES1; 6 supporting wireless terminals, the switch detects on the basis of the address that the set-up message is addressed to a mobile terminal and performs location inquiry to a home network C.2; 2 of the terminal MT 4 (step 3). The home network has a data base HLR 7 which comprises the information about the temporary and permanent addresses of mobile terminals associated with the network. The subscriber data base HLR 7 returns to the switch MES1 6 a temporary address of mobile terminal MT 4 (step 4), i.e. the address B.3.3 of an anchor switch MES2; 8 associated with a base station AP1 to which the mobile terminal has last registered. The switch MES1; 6 changes the temporary address B.3.3 as a destination address of the connection set-up message, places the original destination address C.2.11 to another message field (for instance 'called party subaddress') and sends the set-up message further, according to a PNNI protocol, towards a visitor network B.3; 3 (steps 5, 6 and 7). When the set-up message arrives at the switch MES2; 8 of the visitor network, the switch removes the encapsulation by reading from another message field the original destination address C.2.11,

replaces the temporary destination address B.3.3 with the original address and sends the set-up message to the mobile terminal MT (steps 8 to 9) through the base station AP1.

Figure 4 also shows a second base station AP2 of the network B.3, said base station being associated with the same anchor switch as the base station AP1. When the mobile terminal moves within the service range of the anchor switch MES2, for instance from the area of base station AP1 to that of base station AP2, location information is not necessarily updated at the subscriber data base HLR 7 of network C. If there are many base stations or, correspondingly, if traffic to the peer group B.3 increases, the traffic causes congestion in anchor switch MES2.

Figure 5 shows a peer group B.3; 3 with a plural number of base stations. If the traffic of all the base stations was routed via switch MES2, before long the switch would be excessively loaded. The situation could, in principle, be solved by adding more anchor switches to peer group B.3, but the generic problem of traffic being forced through a single switch would remain unsolved and the advantage the network structure offers for guided routing could not be made use of. Quality of service would not improve significantly and yet the signalling related to location updating would increase unnecessarily, because location updating to the home network would always have to be made when moving from one anchor switch area to another.

Figure 5 illustrates an advantage offered by the present invention in a case such as the one described above. The networks A, B.3 and C.2 represent separate PNNI peer groups. In the example some of the peer groups belong to different levels of hierarchy, but the hierarchy of the peer groups in relation to each other is not essential to the invention. Steps from 1 to 3 take place as in Figure 4. In the present invention, a temporary address of a mobile terminal MT is stored at a subscriber data base HLR of the home peer group C.2 in such a way that a permanent address of the mobile terminal MT is associated with an address B.3 of the peer group to which the terminal has last registered. Said address B.3 is returned to switch MES1 as a response to a location inquiry (step 4). Switch 6 changes the destination address of the connection set-up message to a temporary address, which is the address B.3 of the peer group, places the original destination address C.2.11 to the message field 'called party subaddress' and sends the set-up message further, according to the PNNI protocol, to the visitor network B.3

(steps 5 and 6).

When the set-up message arrives at the border node B.3.1 of the visitor network, border node 9 identifies the set-up message as one that is addressed to the mobile terminal MT 4. The identification may be based on for instance that the border node detects that the destination address of the message is a peer group address and not a switch address. The identification may also be based on another mechanism and it is not as such essential to the invention. If border switch 9 is not a switch supporting wireless terminals, it routes the set-up message to a peer group switch that supports wireless terminals, by performing the routing according to a PNNI protocol. If border node B.3.1 is a switch supporting wireless terminals, it routes the set-up message to the base station AP2 according to a PNNI protocol, for instance over path 7a, 8a, 10 or path 7b, 8b, 9b, 10.

As long as the mobile terminal MT moves within the peer group B.3, registration in base stations AP1 to AP4 does not cause updating in the location register HLR 7. Information about the serving base station of the mobile terminal MT is available for use, according to the invention, to the nodes in peer group B because of location information flooding. Only if the mobile terminal registers to a new peer group, location information is updated to home node group C.2.

It is apparent to a person skilled in art that as technology advances, the basic idea of the invention can be implemented in various different ways. The invention and its embodiments are therefore not restricted to the above described examples, but they may vary within the scope of the claims.

CLAIMS

1. A connection-oriented packet network comprising hierarchically arranged peer groups (1, 2, 3), in which each member of a peer group is arranged to know at least traffic parameters significant for routing to other members within the respective peer group, said network comprising at least one home data base (7) for storing location information of mobile terminals (4) or mobile subscribers in the form of temporary addresses, **characterized** by the temporary location information in the home data base (7) comprising an address of a peer group (3) in which the mobile terminal or mobile subscriber is last registered and that said parameters significant for routing comprise information for an internal routing within a peer group.

2. A network according to claim 1, **characterized** by

the network or the mobile terminal being arranged to update the temporary location information in the home data base when the terminal moves from one peer group to another.

3. A network according to claim 1 or 2, **characterized** by comprising

a first node (6), which supports the management of mobile terminals and which is arranged to inquire, in response to a connection set-up message it receives, of said home data base (7) a temporary address of the mobile terminal or mobile subscriber and to route the message to said temporary address;

a border node (9) of a destination peer group (3), in which the mobile terminal is registered, is arranged to detect on the basis of the set-up message received that the set-up message is addressed to the mobile terminal or mobile subscriber, and to route the set-up message forward within the peer group.

4. A network according to claim 3, **characterized** in that said border node, in response to a set-up message addressed to the mobile terminal, routes the set-up message forward within the same peer group to another node, which supports the management of mobile terminals, said other node being arranged, in response to the message it receives, to route the set-up message to the mobile terminal.

5. A network according to claim 3, **characterized** in that said border node supports the management of mobile terminals and, in response to

a set-up message addressed to a mobile terminal, routes the set-up message to the mobile terminal.

6. A network according to any one of claims 3 to 5, **characterized** in that the border node is arranged to detect that a message is addressed to a mobile terminal when the destination address of the set-up message is a peer group address.

7. A network according to any one of claims 1 to 6, **characterized** by said nodes being ATM switches.

8. A network according to claim 1, **characterized** in that said traffic parameters comprise an identity or an address of a group member serving the addressed mobile terminal or mobile subscriber.

9. A mobile terminal for a connection-oriented packet network said network comprising hierarchically arranged peer groups (1, 2, 3) in which the members of a peer group are arranged to know traffic parameters significant for routing to other members in the respective peer group, said network comprising at least one home data base (7) for storing location information of mobile terminals or subscribers in the form of temporary addresses,

characterized by

said temporary address comprising the address of a peer group (3) in which the mobile terminal or subscriber is last registered, and

the mobile terminal being arranged to update the location information in the home data base as it moves from one peer group to another.

10. A method for routing a message in a connection-oriented packet network comprising hierarchically arranged peer groups (1, 2, 3), in which the members of each peer group know the traffic parameters significant for routing to other members in the same peer group, said method comprising the steps of

receiving at a first network node (6), which supports the management of mobile terminals (4), a connection set-up message comprising a permanent address of a called mobile terminal or mobile subscriber;

sending from the first network node (6) a routing information inquiry to a home data base (7) of the called mobile terminal or mobile subscriber, the location information of mobile terminals or subscribers being stored in the data base in the form of temporary addresses;

providing to the first network node (6), as a response, the address

of the called mobile terminal or subscriber;

routing the connection set-up from the first network node (6), from the switch onward, by using said temporary address as a destination address of the connection,

characterized by

storing, in said home register (7), the address of a peer group (3) in which the mobile terminal or subscriber is last registered as the temporary address;

routing the connection set-up on the basis of said peer group address to the peer group (3) concerned;

routing the connection set-up arrived at the peer group forward within the peer group using the traffic parameters significant for routing.

11. A method according to claim 10, **characterized** by

receiving at a border node of the destination peer group the connection set-up message routed on the basis of the peer group address;

detecting that the set-up message received is addressed to a mobile terminal, and

routing the set-up message forward within the peer group.

12. A method according to claim 10 or 11, **characterized** by

routing the message addressed to the mobile terminal from a border node to another node in the same peer group, said other node supporting the management of mobile terminals;

routing the message from said other node to the mobile terminal.

13. A method according to claim 10 or 11, **characterized** by

routing the message from the border node supporting the management of mobile terminals directly to the mobile terminal.

14. A method according to any one of claims 10 to 13, **characterized** by detecting the set-up message a set-up message addressed to a mobile terminal when a destination address in the set-up message is a peer group address.

15. A method according to any one of claims 10 to 14, **characterized** in that said connection-oriented packet network is an ATM-based telecommunication network.

16. A method according to any one of claim 10, **characterized** in that said traffic parameters comprise an identity or an address of a group member serving the addressed mobile terminal or mobile subscriber.

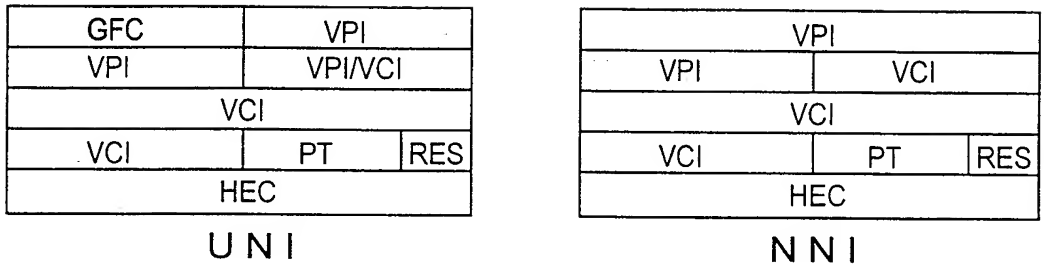


Fig. 1

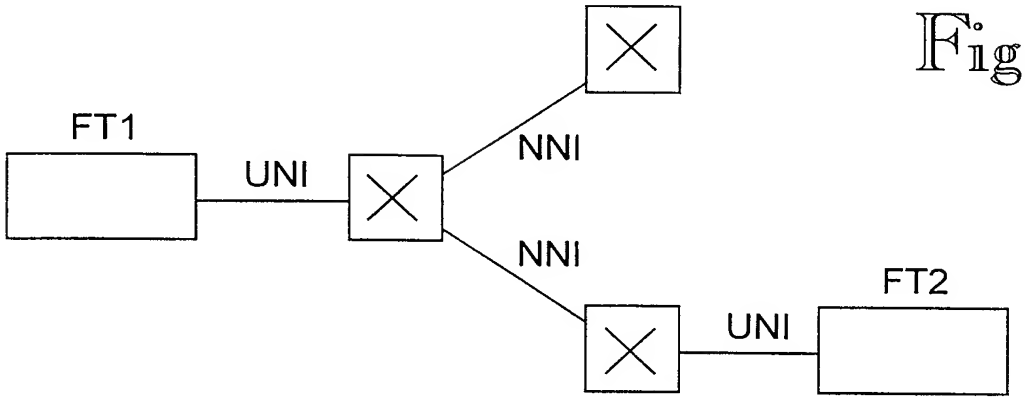


Fig. 2

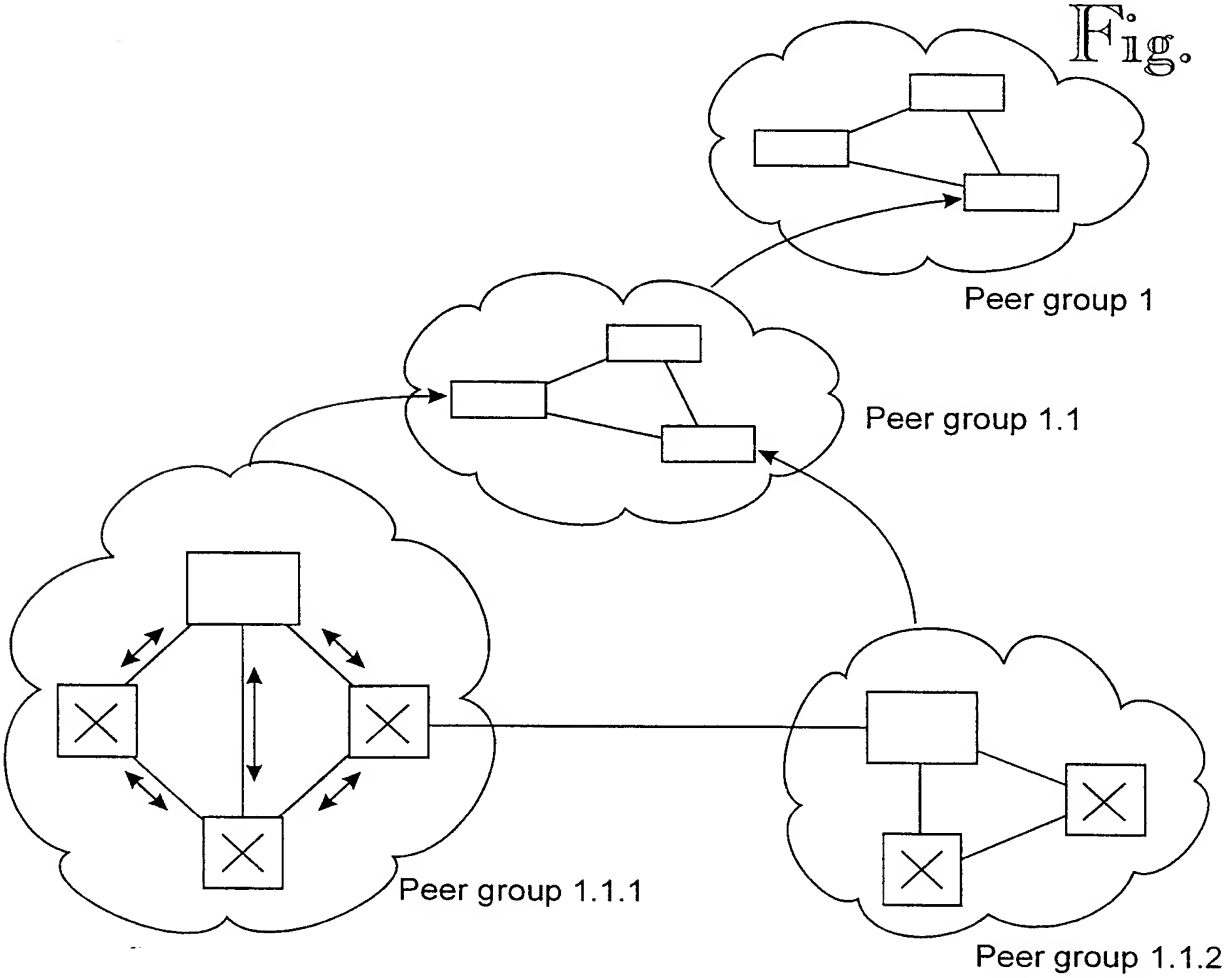
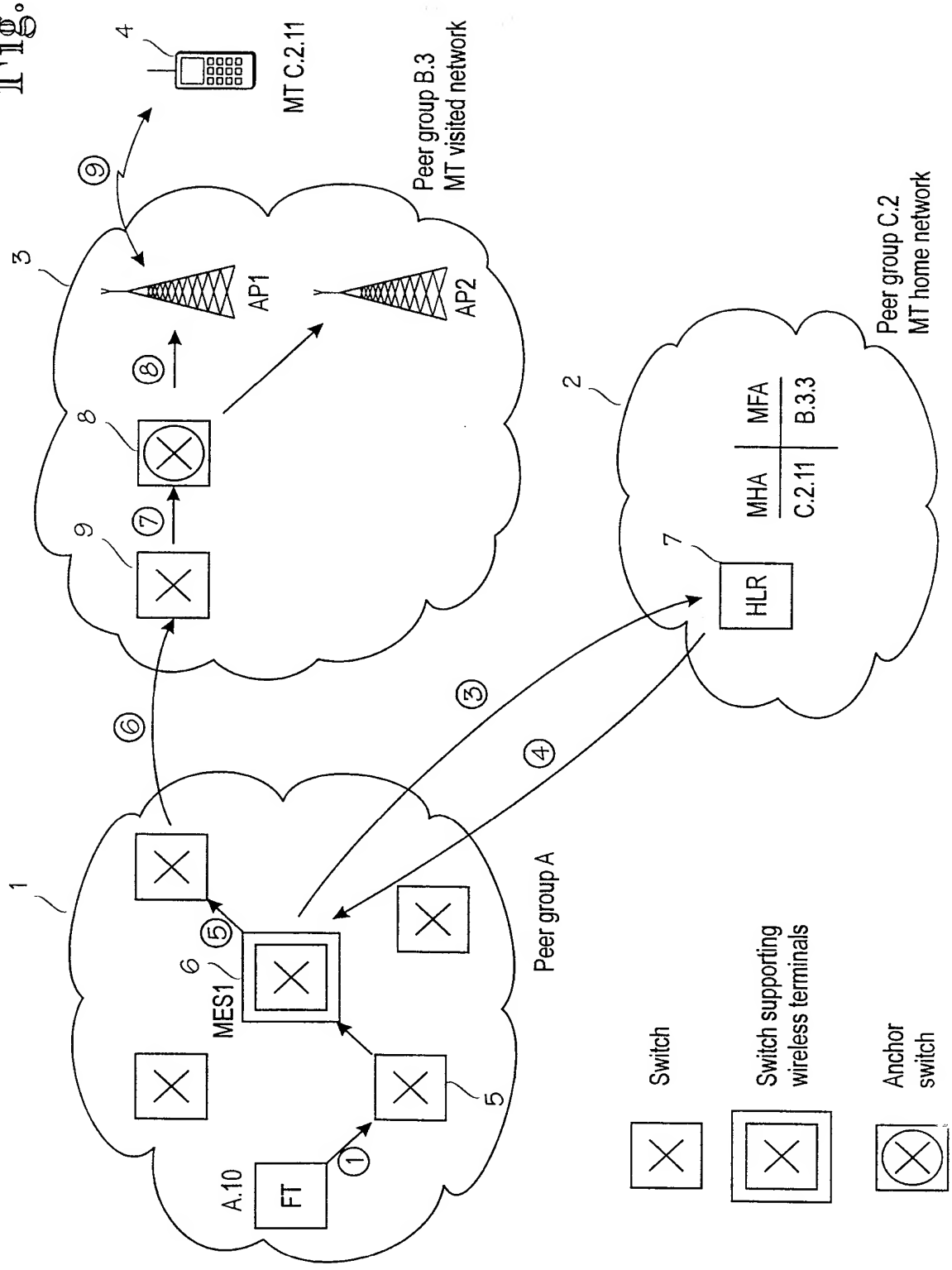


Fig. 3

Fig. 4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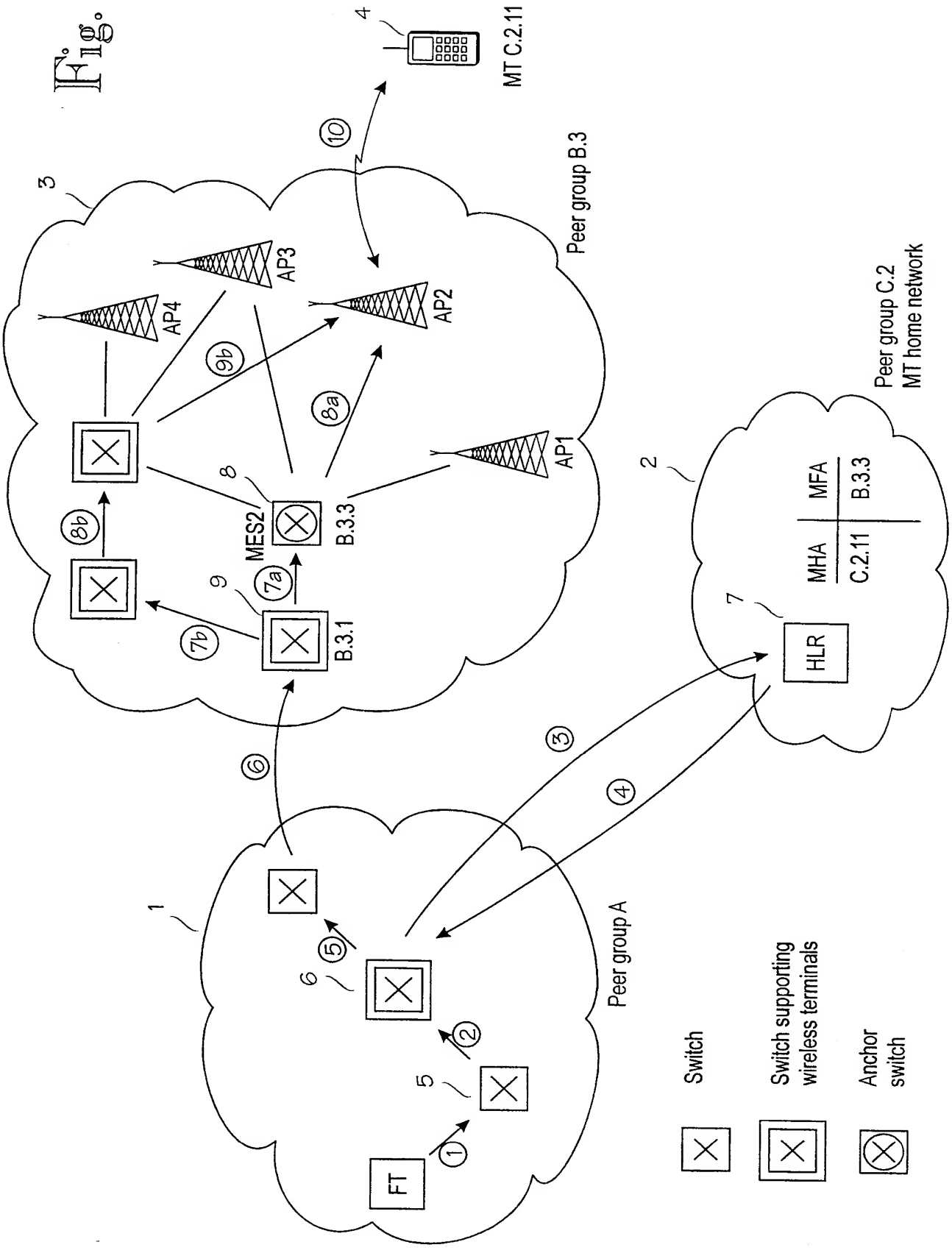
A.10
FT
MES1
HLR
AP1
AP2
MT C.2.11
Peer group A
Peer group B.3
MT visited network
Peer group C.2
MT home network
MHA
C.2.11
MFA
B.3.3
Switch
Switch supporting wireless terminals
Anchor switch

Fig. 5


FT
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AP1
AP2
AP3
AP4
MES2
B.3.3
B.3.1
HLR
MHA
MFA
C.2.11
B.3.3
MT C.2.11
Peer group A
Peer group B.3
Peer group C.2
MT home network
Switch
Switch supporting wireless terminals
Anchor switch